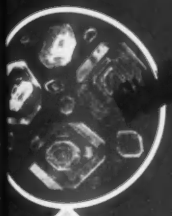
# CHEMISTRY





## The CBAC Laboratory Program



APRIL
1961

50¢

Thirty-fourth Year

A SCIENCE SERVICE PUBLICATION

# Chemistry and Non-Scientists

➤ IN THE LAST six issues of CHEMISTRY we have written about the importance of chemistry to various other fields of science. Since this is the last issue of the year, we cannot overlook the opportunity to point out the importance of chemistry to people who are not in a field of science.

Let us examine the life of a hypothetical non-scientist. How has chemistry affected the way he lives?

We find him sleeping on a foam rubber mattress under a blanket made of synthetic fabric. He wakes up to music from a transistorized radio in a polystyrene plastic case.

Our hero walks on floors waxed with a plastic-based self-polishing material to a bathroom with vinyl plastic tiles. He brushes his teeth with a plastic-handled toothbrush having synthetic bristles. The toothpaste that he uses contains fluoride or other decay-preventing chemicals. His electric razor has a polystyrene case and a polyethylene plastic-coated cord.

In the meantime, our hero's wife has prepared coffee from instant coffee using a non-fattening chemical instead of sugar. His glass of water is as pure as chemical processing will make it. The dishes in this kitchen are washed with a new synthetic detergent.

The clothes worn by our non-scientist friend have been made wash-and-wear, soil resistant and wrinkle resistant by chemical treatment. The car that he drives to work is made possible by the discoveries of chemistry. Periodically during the day he takes antihistamine chemicals to control his allergy and tranquilizing chemicals to control his tensions. The cigarettes that he smokes are made from tobacco and paper that have been chemically treated to insure their quality.

**CHEMISTRY**

Vol. 34, No. 8 Formerly Chemistry Leaflet April, 1961

Including The Science Leaflet

Published monthly, September through April, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 326 W. Beaver Ave., State College, Pa. Second class postage paid at State College, Pa., and at additional mailing offices. Address subscription and editorial communications to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

$4 a Year; Two-Year Subscriptions $7; Your Own and a Gift Subscription $7 a Year. 50¢ a Copy. Ten or more subscriptions to the same address: $2.90 a Year each. No charge for Foreign or Canadian Postage.

**Editor:** WATSON DAVIS **Assistant Editor:** BURRELL WOOD

**Consulting Editor:** PAULINE BEERY MACK (Editor 1927-1944)

**Editor in Memoriam:** HELEN MILES DAVIS (1944-1957)

# THE CBAC LABORATORY PROGRAM

**This new introductory chemistry course was first described in the February 1960 issue of CHEMISTRY. Its main feature is the attempt to organize a course around the concept of the chemical bond. This experiment in curriculum development is being financed by grants from the National Science Foundation to Earlham College in Richmond, Indiana. The CBAC work has been reported also in the September 1960 issue of CHEMISTRY. This article reports the development of the laboratory portion of the course.**

If there is any one characteristic of the basis for CBA Chemistry, it is probably the belief that chemistry is inherently fascinating and that this fascination can be seen by students early in their exposure to the subject. To reveal the fascination, it is not enough, however, to have the student memorize the data of chemistry. Chemistry is more than the facts which make up the information possessed by chemists. Rather, chemistry as practiced is a powerful process for uncovering and extending natural phenomena. The power resides in the combination of ideas and facts or of concepts and experiments.

The course, then is organized to aid the student in his study of the interaction of conceptual schemes with observation and experiment. Successful laboratory work in the CBA program means that the student not only collects data in the laboratory, but he

also applies ideas to his data. The laboratory experiments are presented as problems to be explored or, if you wish, as puzzles to be solved. In so far as possible, it is left to the student to decide what information he needs to solve the problem. Ideally, some information should come from the laboratory and some from the literature. These are fitted into a logical scheme based on a set of assumptions and often some mental model. Logical reasoning leads to a reasonable solution to the problem. In most cases, either the solution to the problem or some of the difficulties will suggest still other paths to be explored. Where time and facilities permit, the student is encouraged to follow up such "extensions" as may intrigue him.

## Results Not Predetermined

In such a setting, it is important to note that laboratory experiments do not automatically lead to a predetermined result known only to the teacher. It is the ability of the student to follow and even to construct a line of argument that is the hallmark of good work. The importance of quantitative and reproducible work is not minimized, but it is not made a goal in itself, Neither is the learning of manipulations treated as an end in itself, although a number of experiments are deliberately designed to acquaint the student with important laboratory techniques, but only as incidental to the solution of a particular problem.

The emphasis in the laboratory program is placed on the relationship between the structure of a substance and its properties, on the energies associated with chemical systems, and on the pathways of chemical reactions. The laboratory activities present chemistry to the students as an experimental science so that the students see chemistry as a practicing chemist sees it.

## Experiments Designed

Each experiment is based on a specific question or problem. After determining what data should be obtained in the laboratory, an appropriate experimental procedure is designed to obtain this information. When the actual laboratory work is completed, the resulting data are evaluated and interpreted. Appropriate conclusions are drawn relative to the question being investigated. Thus it is possible to emphasize three features of the laboratory program. These are (1) the exploration of ideas, (2) the use of experimental data, (3) the promotion of independent investigations.

When exploring ideas in the laboratory, an experiment is regarded as a device for obtaining information. The purpose of an experiment is not to verify a foreknown answer to a designated question, but to provide data which enables the students to propose a restricted answer, restricted by the design of the experiment. In modern research, scientific answers are generally subject to similar restrictions. By using this approach, numerous ways of using experimental data can be presented and independent laboratory investigations can be promoted. For example, in the experiment involving the heating of a hydrate,[1] the object is not merely to

[1] Laboratory, C. B. A. C., Volume 2, Second Edition, Experiment 20.

determine the formula of the hydrate but to obtain evidence which partly reveals the structure of the hydrate. When the data obtained are analyzed, it is apparent that heating the hydrate results in changes other than the loss of water. Further considerations lead to the structural characteristics of the hydrate. From this point, several questions can be raised concerning the nature of other solvates which can lead on to several independent laboratory investigations. Thus, as the data are collected in an experiment designed to answer one question, they can be examined as sources of answers to other questions. While the original question might not be completely answered, a host of new questions might be posed and partially answered.

## Models and Black Boxes

Throughout the course, considerable use is made of mental models. Model building is presented as a way of thinking and as a means of organizing scientific thought. In the laboratory, the students are introduced to models in Experiment 1 (Observation, "Black Boxes," and the Scientific Model).[2]

In this experiment, the student is given a taped box containing an unknown object. By using the observations resulting from the manipulating of the box, the students develop a model which represents the unseen object in the box.

"Superficially it might appear to the student that this experiment has little relevance to chemistry. It is therefore essential that he realizes very early in the course that chemistry is as much a way of thinking and handling observations (i.e., a methodology) as of manipulating Bunsen burners and reagents. Hence, in a very real sense this experiment is part of his training in chemistry.

The latter part of the experiment is especially crucial in this respect. Indeed, it serves to set the tone for the entire CBA course. The student is here dealing with the so-called "black box" and the "scientific model." In later experiments he will be dealing with chemicals and chemical systems as "black boxes."

The black box is, of course, any physical system which we use or study without understanding its interior functions of "knowing its content." The Geiger counter might serve as a typical example of a black box for the average person. The layman can readily use it to detect radioactive materials without understanding how it works. To the designer of a Geiger counter, on the other hand, it is not a black box; he is thoroughly familiar with its operation and the way it functions. More likely than not, however, to the designer of the Geiger counter radioactivity itself may very well be a black box. He accepts it as a fact without understanding it.

## Explains Observation

The "scientific model" is a man-made creation designed to explain observations and natural phenomena. It consists of certain assumptions and hypotheses which serve to account for all that has been observed. A good

[2] Laboratory, C. B. A. C., Volume I, Second Edition.

scientific model will predict hitherto unobserved phenomena. To the extent that it fails to predict correctly, it must either be modified or rejected in favor of a new model.

To the extent that his reasoning is sound and valid, it is of little import that he determine the precise contents of the box. His methodology is paramount in judging his performance, *not* his happening upon the "right answer" through fallacious reasoning or sheer chance. The crucial question is, "is the student's model capable of reproducing all the behavior as observed from outside the box?"[3]

## Sequential Experiments

Several series of experiments are used in which one major idea or concept is investigated by several different approaches. Each successive experiment involves a more thorough consideration of the idea than the preceding one. There are three experiments which deal with models, Experiment 1 (Observation, "Black Boxes," and the Scientific method), Experiment 8 (The Chemistry of Electron Pairs)[2] and Experiment 12 (Metals and Metal Crystals).[4] In each succeeding experiment, the resulting model is found to be more useful than the previous one for considering chemical systems. In other series, attention is centered on rate processes, on thermochemistry, and on the stability of compounds.

[3] Laboratory, C. B. A. C., Teachers' Guide, Volume I, Second edition, pages 20-22.

[4] Laboratory, C. B. A. C., Volume 2, Second Edition.

## Extensions

After completing an experiment, the students are encouraged to continue the investigation. Frequently, the students will raise questions which suggest additional laboratory work. This can be illustrated by presenting some of the studies which students made during the current trial program in conjunction with Experiment 9 (Diffusion-Effusion).[2]

In this experiment, students are given the problem of determining the relative rates of diffusion of $HCl(g)$ and $NH_3(g)$ and of comparing the ratio of the relative rates of diffusion to the molecular weights of the two gases. In general, the equipment and procedure used to obtain the necessary data involved the following. A piece of glass tubing was mounted on a ring stand so that the tube was in a horizontal position. A cotton plug with concentrated ammonium hydroxide and a second plug saturated with concentrated hydrochloric acid were placed simultaneously at opposite ends of the tube and the time noted. When the white ring of ammonium chloride was observed in the tube, the time was recorded and the distance of the ring from each end of the tube was measured. After completing the calculations, the students interpreted the data and presented their conclusions.

## Post-Lab Discussion

During the post-laboratory discussion, the students asked questions which could not be answered in terms of the data collected. Some of the students designed procedures which were employed to obtain the

necessary data. The following studies and investigation exemplify the nature of the extensions used in the program. Each of these extensions was conducted in different high schools after the original assignment had been completed.

One group of students investigated the effect of the length and the diameter of the tube on the relative rates of diffusion. In another high school, the students ran a series of experiments in which the reaction tube was in a vertical position rather than in a horizontal position. After obtaining these data, they continued their work by comparing the relative rates when the ammonia was introduced at the top of the tube to that obtained when the hydrochloric acid was introduced in this position.

Several studies were reported in which the students used various methods of controlling the quantities of reagents used to determine the effect of concentration on the diffusion rate. This involved the designing and construction of special equipment. Since aqueous reagents were used, one group of students developed a useful procedure to determine what effect the rate of evaporation had on the rate of diffusion. A study was conducted to determine separately the rate of diffusion of each of the reagents. By using moist litmus paper, the students determined the time required for the substance to pass through the tube. These rates were then compared to those obtained from the previous laboratory work.

In several schools, investigations were made as to the nature of the ammonium chloride formed during the reaction. By using different reaction conditions, the ammonium chloride could be formed as a complete ring or series of bands. They supplemented their report on this extension with photographs. Other students studied the formation of the ring as a function of time.

It is interesting to note that several of these investigations were successful entries in local science fairs. In a preliminary evaluation of this feature of the laboratory program, it appears that these extensions serve as a useful device for promoting independent student work in chemistry.

## Correlation of Text and Experiments

In Chapter VIII (Energy and Chemical Change)[5] heats of formation and of reaction are presented in detail. To explore these ideas fully, Experiment 11 (The Heat of Formation of Solid Ammonium Chloride)[4] is used to illustrate the calculation of the reaction energy for a reaction which does not lend itself to direct experimental determination. The students determine experimentally the heat of neutralization of hydrochloric acid and aqueous ammonia and the heat of solution of ammonium chloride. From the literature, they obtained the values for the heat of formation of aqueous ammonia from gaseous nitrogen and hydrogen and of hydrochloric acid from gaseous hy-

[5] CHEMISTRY, C. B. A. C., Volume I, Second Edition.

drogen and chlorine. By summation, two experimentally determined values and the two literature values give the heat of formation of solid ammonium chloride. The correlation of Chapter VIII and Experiment 11 illustrate the use of the laboratory to explore theoretical concepts presented in the textbook.

### List of Experiments

The experiments in the current laboratory program are:

1. Observation, "Black Boxes," and the Scientific Model
2. An Introduction to the Nature of Chemical Reactions
3. Some Quantitative Aspects of Chemical Reactions
4. Reaction of Methane and Oxygen
5. A Comparison of Sodium Chloride and Naphthalene
6. An Aqueous Solution of a Sodium Chloride
7. A Comparison of Carbon Dioxide and Oxygen
8. The Geometry of Electron Pairs
9. Diffusion-Effusion
10. Heat of Vaporization
11. The Heat Formation of Solid Ammonium Chloride
12. Metals and Metal Crystals
13. Polarity
14. Identification of Substances by Chemical Properties
15. The Periodic Relations of the Elements
16. Some Chemistry of Oxygen-Containing Compounds
17. Chemistry of the Halogens and Halogen Compounds
18. Equilibrium
19. Acids and Bases
20. Further Studies on Thermal Decomposition of Oxygen-Containing Compounds

It has not proved easy to design laboratory experiments of the kind indicated. Our main criteria for an effective laboratory experiment are: it should be fitted tightly into the text so that it makes an important contribution to the pattern of the course; it must involve both the acquisition of data by the student and the execution of a logical argument, and it should become one of the threads in the course which contributes to at least a few subsequent discussions. We are still working to develop experiments which correspond to such criteria.

## *Non-Stick Rubber Developed*

► NATURAL RUBBER has been given a non-stick surface by developing a thin layer of fluorine-containing synthetic rubber.

A chemical treatment developed by Quantum, Inc., of Wallingford, Conn., gives the rubber a slippery surface without affecting its elasticity and other properties.

Irradiation of natural rubber sheeting with ultraviolet light produces a surface to which methyl acrylate can be grafted.

The methyl acrylate layer is hydrolyzed to give its acid form and then fluorinated with sulfur tetrafluoride.

# CHEM Exam Answers

**Last month we printed the questions in the first examination given the students of the Chem Study group. We promised to give you the answers this month. They are printed below.**

| | | | | |
|---|---|---|---|---|
| 1. B | 8. A | 15. D | 22. D | 29. E |
| 2. C | 9. A | 16. E | 23. D | 30. D |
| 3. B | 10. A | 17. E | 24. C | 31. C |
| 4. C | 11. A | 18. A | 25. C | 32. A |
| 5. B | 12. C | 19. A | 26. B | 33. B |
| 6. C | 13. B | 20. B | 27. A | 34. E |
| 7. C | 14. C | 21. D | 28. D | 35. E |

# New Amino Acid

➤ A NEW amino acid has been discovered by biochemists at the University of Cincinnati College of Medicine.

The new amino acid, tentatively designated as beta-hydroxyproline, was found in a collagen, the protein that makes up connective tissues such as tendons. It was found in the collagen of the Achilles tendon in cattle.

Announcement of the discovery was made to the Federation of American Societies for Experimental Biology by Dr. James D. Ogle, Dr. Milan A. Logan and Ralph Arlinghaus of the University of Cincinnati College of Medicine.

At present, Dr. Ogle said, no one knows what role the new amino acid plays or where else it is found.

This is the first amino acid with a basically new structure to be discovered in more than 25 years. Only 20 other amino acids, the building blocks of protein, have been found in mammalian tissue since the first was described in 1810.

The first clue to the existence of the new amino acid came, Dr. Ogle said, when a strange color reaction occurred during chromatographic separation, with an ion exchange resin, of a piece of the collagen molecule into its component amino acids.

The new amino acid makes up two-tenths to three-tenths of one percent of the particular collagen in which it was found. Gamma-hydroxyproline, by comparison, constitutes 10% to 12% of this collagen.

School Mathematics
Study Group

# New Courses in Mathematics

**An adequate understanding of mathematics is an essential skill needed by all chemists. For that reason, CHEMISTRY reports the various efforts to improve the teaching of mathematics in the schools. This article describes the developments of School Mathematics Study Group working under Wr. E. G. Begle of Yale University.**

## History

➤ IN THE SPRING of 1958, after consulting with the Presidents of the National Council of Teachers of Mathematics and the Mathematical Association of America, the President of the American Mathematical Society appointed a small committee of educators and university mathematicians to organize a School Mathematics Study Group whose objective would be the improvement of the teaching of mathematics in the schools. Professor E. G. Begle was appointed Director of the Study Group, with headquarters at Yale University. In addition, the organizing committee appointed an Advisory Committee, consisting of college and university mathematicians, high school teachers of mathematics, experts in education, and representatives of science and technology, to work with the director.

The National Science Foundation, through a series of grants, has provided very substantial financial support for the work of the Study Group.

## Objectives

The world of today demands more mathematical knowledge on the part of more people than the world of yesterday and the world of tomorrow will make still greater demands. Our society leans more and more heavily on science and technology. The number of our citizens skilled in mathematics must be greatly increased; and understanding of the role of mathematics in our society is now a prerequisite for intelligent citizenship. Since no one can predict with certainty his future profession, much less foretell which mathematical skills will be required in the future by a given profession, it is important that mathematics be so taught that students will be able in later life to learn the new mathematical skills which the future will surely demand of many of them.

To achieve this objective in the teaching of school mathematics three things are required. First, we need an improved curriculum which will offer students not only the basic mathematical skills but also a deeper understanding of the basic concepts and structure of mathematics. Second, mathematics programs must attract and train more of those students who are capable of studying mathematics with profit. Finally, all help possible must be provided for teachers who are preparing themselves to teach these challenging and interesting courses.

Each project undertaken by the School Mathematics Study Group is

concerned with one or more of these three needs.

## Projects

I. - Mathematics for Grades 7 & 8

The School Mathematics Study Group believes it particularly important that greater substance and interest be given to the mathematics of grades 7 and 8. Our general point of view has been to think of these grades not just as the end of elementary school mathematics but also as a foundation for the work of the senior high school. The curriculum for these grades should include a sound intuitive basis for the algebra and geometry courses to follow.

To provide a concrete illustration of this kind of curriculum, textbooks for these two years have been prepared.

Accompanying each of these texts is a commentary for the teacher. These commentaries include not only the usual materials (discussion of teaching problems, solutions for the exercises, etc.) but also discussions and deeper expositions of the mathematics.

These texts evolved from a series of experimental junior high school units which were prepared at the first SMSG writing session at Yale University in the summer of 1958. In the following summer a preliminary version of a 7th grade text and a collection of 8th grade units, including much of the material in these experimental units was prepared. In the summer of 1960 a revised version of the 7th grade text and a preliminary version of an 8th grade text were prepared. A revision of the 8th grade text will be carried out in the summer of 1961.

During the intervening academic years, these materials were used in a number of experimental centers, involving approximately 100 teachers and 8,000 students each year. Feedback from the teachers was used extensively each summer in the revision of these materials.

II. - Mathematics for Grades 9 through 12

This project is devoted to the production of a series of sample textbooks for grades 9 through 12. For the most part the topics discussed in these textbooks do not differ markedly from those included in the present-day high school courses for these grades. However, the organization and presentation of these topics is different. Important mathematical skills and facts are stressed, but equal attention is paid to the basic concepts and mathematical structures which give meaning to these skills and provide a logical framework for these facts.

Preliminary versions of these texts were prepared at a writing session held at the University of Colorado in the summer of 1959, using detailed outlines which had been prepared at the Yale writing session in the summer of 1958.

As with the texts for grades 7 and 8, a commentary for the teacher accompanies each text.

These texts were used in a total of 37 experimental centers involving approximately 260 teachers and 18,000 students. As in the case of the project described above, the teachers using these texts reported on their classroom experiences and, on the basis of these reports, the texts were revised during the summer of 1960 at a writing session at Stanford University.

During the summer of 1961 a pre-

liminary version of another geometry text will be prepared. This text will emphasize analytic geometry, and will be tried out in a number of experimental centers during 1961-62.

III. - Monographs

A third project is aimed at the production of a series of short expository monographs on various mathematical subjects. The primary objectives of such monographs are: to disseminate good mathematics at the secondary school level which will supplement the usual high school curriculum; to awaken interest among gifted students; and to present mathematics as a satisfying, meaningful human activity. They are not intended as texts, but rather as supplementary reading material for students, their teachers, and the general educated lay public.

Outstanding mathematicians will write these monographs. In order to be sure that they are understandable and enjoyable by the audience for whom they are intended, preliminary versions will be read by high school students and experienced high school teachers. Their comments, criticisms, and suggestions will be passed on to the authors to form a basis for revision, if necessary.

These monographs will be published as paperbacks by a commercial publisher. The first six will be ready late in the spring of 1961.

The first six monographs are:

*Numbers: Rational and Irrational*, by Ivan Niven.

*What is Calculus About?*, by W. W. Sawyer.

*An Introduction to Inequalities*, by Edwin Beckenbach and Richard Bellman.

*Geometric Inequalities*, by Nicholas D. Kazarinoff.

*The Contest Problem Book. Problems from the Annual High School Contests of the Mathematical Association of America*, compiled by Charles T. Salkind.

*The Lore of Large Numbers*, by Philip J. Davis.

IV. - Teacher Training Materials

Practically all recommendations for improved secondary school mathematics curricula that have been seriously proposed, either by SMSG or by others, involve aspects of mathematics which have not, in the past, been included in the normal subject matter training of secondary school teachers. This project is devoted to the production of materials specifically for teachers who wish the additional training in mathematics needed to teach an improved curriculum. Particular attention is paid to materials suitable for use in summer and in-service institutes, such as those sponsored by the National Science Foundation.

Two series of publications are under way. The first is a series of study guides for teachers who wish to improve their professional competence by study either individually or in small groups. A study guide in algebra is currently being revised and others on analysis, geometry, logic, number theory, and probability are in preparation.

The second series consists of expositions of various topics in mathematics designed explicitly for in-service teachers. Five of these are already available and others will be available in the near future.

V. - Mathematics for Less Able Students

The sample textbooks mentioned previously for grades 9 through 12 were written explicitly for college-capable students. This particular project is devoted to the construction of an improved curriculum for slower students. This work is under the guidance of the Panel on Underdeveloped Mathematical Talent. As a first step it will test the hypothesis that such students can learn the kind of mathematics contained in the SMSG 9th and 10th grade texts provided that the material is presented in a less formal fashion and with more concrete illustrations, and provided that the students are allowed to proceed at their own pace. Appropriate revisions of these texts were made in the summer of 1960 in order to carry out this test. A similar test is being conducted with the SMSG texts for grades 7 and 8.

Pending definite information on the feasibility of these materials the books are not available for general distribution at this time.

VI. - Elementary School Mathematics

In this project SMSG will undertake a critical study of the elementary school mathematics curriculum from the point of view of: increased emphasis on concepts and mathematical principles; the grade placement of topics in arithmetic; the introduction of new topics, particularly from geometry; and supplementary topics for the better students, for example from number theory.

A start on this was made in the summer of 1960 in a writing session at Stanford University. A complete course for grade 4 and selected units for grades 5 and 6 were prepared. A commentary for the teacher accompanies each unit.

These units are now being used in a total of 27 experimental centers involving approximately 12,000 students with 150 fourth grade, 110 fifth grade, and 110 sixth grade teachers.

These teachers report their classroom experiences and, on the basis of these reports, the units will be revised during the summer of 1961. The work for grades 5 and 6 will be completed, and during the academic year, 1961-62, a complete course of study for mathematics grades 4, 5, and 6 will be classroom tested.

## Other Activities

Text materials for gifted students are badly needed. Some material of this kind is included, as optional sections in the textbooks mentioned above and others have been published separately. Detailed plans are being considered for a considerable expansion of the program of publication of brief supplementary materials for students of varied ability levels.

In another direction, an experiment is now under way which will test the feasibility of a correspondence course for gifted students. This, if successful, will be one method for providing for the gifted students located in schools too small to offer special sections or courses.

Many students develop in school a negative attitude toward mathematics and hence are lost to science and technology. The SMSG sample textbooks are now being studied, by a group including both mathematicians and social scientists, to see how they affect attitudes toward mathematics.

The Educational Testing Service is currently conducting a study of the performance of students using SMSG texts as compared to those using conventional texts.

A careful study of teaching machines, programmed learning, etc., will be carried out with special reference to the SMSG text materials.

**Advisory Committee**

A. A. Albert, University of Chicago.
F. B. Allen, Lyons Township High School, LaGrange, Illinois.
E. G. Begle, School Mathematics Study Group, Yale University.
Lipman Bers, New York University.
S. S. Cairns, University of Illinois.
G. F. Carrier, Harvard University.
W. L. Duren, Jr., University of Virginia.
H. F. Fehr, Columbia University.
H. V. Funk, Columbia University.
A. M. Gleason, Harvard University.
J. H. Hlavaty, Dewitt Clinton High School, New York.
P. S. Jones, University of Michigan.
L. C. Lay, Orange County State College.
K. O. May, Carleton College.
J. R. Mayor, American Association for the Advancement of Science.
A. E. Meder, Jr., Rutgers University.
E. E. Moise, Harvard University.
P. M. Naghdi, University of California, Berkeley.
R. S. Pieters, Phillips Academy, Andover, Massachusetts.
G. B. Price, University of Kansas.
R. E. K. Rourke, Kent School, Kent, Connecticut.
A. W. Tucker, Princeton University.
Henry Van Engen, University of Wisconsin.
A. D. Wallace, Tulane University.
E. L. Walters, William Penn Senior High School, York, Pennsylvania.
Marie S. Wilcox, Thomas Carr Howe High School, Indianapolis, Indiana.
M. W. Zemansky, The College of the City of New York, New York.

---

For further information of the program, write to: School Mathematics Study Group, Box 2029 Yale Station, New Haven, Connecticut.

# Arithmetic Project

**The improvement of the teaching of arithmetic in the elementary grades is the object of a project at the University of Illinois in Urbana. Dr. David A. Page is director of the group there. This article describes some of the recent activities of this group.**

➤ UNDER a grant of $57,000 the University of Illinois Arithmetic Project has experimented with making motion pictures of classes of children while they are being taught mathematics.

These films are "shot" and produced in the Watertown, Mass. studios of the Physical Science Study Committee.

In addition to the films for teachers, there will be correlated written

material which reviews and goes deeper than the corresponding film. Also this printed material will contain many problems and exercises for the *teacher*. Thus, ideally, a group of teachers could get together a class of their own using our materials. In practice, it will probably be necessary to have at least an occasional session with a local college or high school mathematics teacher.

* * *

The first long document for teachers to be prepared by the U. of I. Arithmetic Project will be available early May (in plenty of time for any summer institute that wants to use it). Is is called, "Number Lines, Functions, & Fundamental Topics." There will be a charge, yet to be determined, to recover costs of paper, duplicating, mailing, etc. Everyone on the Project's mailing list will be notified of the availability of this 100+ page unit, together with ordering instructions and price.

The U. of I. Arithmetic Project is now prepared to go on record officially as strongly in favor of the use of Mathematics Teachers (specialists) who teach mathematics throughout the day (and only mathematics except where size of school or some administrative difficulty requires that one or two other classes be handled by this teacher). When such specialization becomes widespread, as it will, it should be required that any mathematics teacher working anywhere between Kindergarten and 12th grade must have an undergraduate major in mathematics. Such teachers could interchange from time to time between high school and elementary school or could even teach a load split between the high school and the elementary school.

This is not to say that all elementary teachers are incompetent with mathematics or that presently incompetent ones cannot become competent by Institutes and self study. But a simple look at the arithmetic (about a million elementary school teachers!) of the problem shows that it is far easier to choose the one-fifth of these teachers who like mathematics (or at least hate it least) and train them to do the whole job of mathematics instruction than it is to attempt the impossibility of training all elementary school teachers sufficiently. Also such an attempt to train all teachers might meet with justified opposition by representatives of the other subjects.

* * *

Thirty-five elementary school teachers have been selected from over 1200 applicants to attend a National Science Foundation Summer Institute in Mathematics. The instruction for the Institute will be given by the Arithmetic Project Staff together with a few new people for the summer. An example is Dr. Robert Christian of the Mathematics Department at the University of British Columbia.

Along with a heavy load of course work which is almost entirely mathematical in content, teachers will observe a fourth grade demonstration class every morning. This will give them some idea of "how you talk about" the mathematics they are learning when dealing with children together with direct experience showing that the mathematics taught in this institute is appropriate for children in the grades.


**Apparatus Article**

# High Capacity Micro Balance

➤ A NEW higher capacity balance is announced by Cahn Instrument Company, Paramount, California. It is excellent for SPECIFIC ANALYTICAL METHODS involving samples up to one gram, and most methods in MICROCHEMISTRY. It significantly extends the capabilities of the general chemical laboratory, supplementing the chemical analytical balance at the low end of its range.

The new Cahn Gram Electrobalance® weighs samples up to 1.2 grams, weighs small samples to an accuracy of one microgram (0.001 mg).

It is unaffected by temperature, vibration, level, humidity, and stray electrostatic and magnetic fields. It does not require a special balance table nor a special balance room, as previous fine balances did. It is exceptionally rugged, and hard to damage. You can also use it in high vacuum or high pressure, oven or cryostat, dry box or humidity chamber, and read it remotely from outside.

Special training is not required,

even to weigh to one microgram. The single weight dial reads directly in milligrams or micrograms, all operating adjustments are on the front panel, and operating instructions are printed right on the case. Special circuits eliminate computation, such as subtracting container weight, etc. It is thus ideal for production use, and for scientists without extensive training in analytical chemistry.

Eleven ranges, selected by panel switch and choice of loops, allow you to set this one balance for full-scale ranges from 0-1 mg to 0-1 gram. It replaces a number of balances of other types. Precision is 0.001 mg on the lower ranges, 0.01% of range on the higher ones. Accuracy is 0.001 mg on the lowest range, 0.05% of range on the higher ranges. Accuracy of 0.01% of range is available on special order.

New features include an elastic ribbon suspension, instead of knife edges or pivots, which eliminates bearing friction. It has high capacity and zero hysteresis. Symmetrical-beam construction permits taring of heavy sample containers; it improves accuracy and allows counterpoising to minimize the effect of humidity and barometric pressure variations on the sample. The larger sample compartment accommodates samples up to 60 mm diameter, such as Millipore filters, filter paper, and fluffy materials. The Cahn Gram Electrobalance is available with battery power, for portable operation and low cost; or with a new silicon solid-state power supply, which has no expendable components, for those applications which require exceptional long-term stability without adjustment, such as remote weighing in vacuum.

The Cahn Gram Electrobalance is in production now, and is available from franchised scientific instrument dealers throughout the world for prompt delivery. Further information may be obtained from the dealers, or Cahn Instrument Company, 14511 Paramount Blvd., Paramount, California.

## *Predicts Better Anesthetics*

▶ THE BEST anesthetics will be mixtures of compounds whose molecules are of such size and shape as to fit in holes in networks of 20, 24 and 28 water molecules, Dr. Linus Pauling, Nobelist in chemistry, California Institute of Technology, told Science Service.

Dr. Pauling's new theory on the action of anesthetics enables him to describe the chemical substances that will act best as anesthetics.

Dr. Pauling has linked the action of anesthetics with the formation of compounds in which molecules of one substance are trapped in a network of molecules of another substance, such as water. These unusual compounds are called clathrate compounds. Water forms traps that look somewhat like the cells in a honeycomb except they are five-sided instead of six-sided.

**Highlights from the 139th National Meeting of the American Chemical Society at St. Louis in March.**

# New Nylon

➤ A SIMPLE, economical process has been developed for a new kind of nylon that has superior qualities for tire cords, fish lines and wearing apparel, the American Chemical Society was told by Dr. C. F. Horn of Union Carbide Chemicals Company of South Charleston, W. Va.

The new nylon is called nylon 7 because it is a polymer of an amino acid containing seven carbon atoms. Ordinary nylon is called nylon 66 because it is composed of giant molecules produced by combining molecules containing six carbon atoms and two acid groups with molecules containing six carbon atoms and two amino groups. The latest kind of nylon to be introduced into this country from Europe was nylon 6. It is a polymer of an amino acid containing six carbon atoms.

Nylon 7 can be produced by boiling the ethyl ester of aminoheptanoic acid in water. The white waxy-to-brittle product can be stored or spun immediately in strong fibers. This contrasts markedly with the several steps involved in the commercial production of its two chemical cousins, nylons 66 and 6.

Nylon 7 is especially suitable for tire cords since its high softening temperature, 430 degrees Fahrenheit, enables it to withstand the deteriorating effects of the heat build-up from friction. Clear, tough films and molded objects of good impact resistance can be made from this material.

B. T. Freure, H. Vineyard and H. J. Decker joined in the research.

## *Clue to Epilepsy Cause*

➤ A DISCOVERY that should eventually aid in determining the exact cause of epilepsy was reported

Epileptic convulsions have been produced in laboratory rats by massive doses of the common insecticide dieldrin. These convulsions were accompanied by an abnormal chemical condition in the brain of the rats, identical to that found in the human brain during an epileptic seizure.

Dr. E. A. Hosein, assistant professor of biochemistry, and Mrs. Roushan Ara, a graduate student from Pakistan of McGill University reported these findings at the American Chemical Society meeting.

Analysis of the brain fluid from these experimental animals showed that a mixture of biochemicals had been dislodged, and the chemicals migrated to parts of the brain not ordinarily accessible to them. When this mixture of biochemicals was injected into the brain of a normal animal, epileptic-like convulsions were produced.

## Better Motor Oils

➤ A NEW PROCESS uses "thermal diffusion" to concentrate oil molecules whose shapes give them superior lubricating ability.

Motor oils prepared by this process give 50% longer service than ordinary lubricating oils, H. E. Alford of Standard Oil Company's research department in Cleveland reported.

Laboratory tests showed very little thinning out at high temperatures and very little thickening at low temperatures. A four-month road test showed that there was a 35% decrease in oil consumption and a 50% increase in service life of the oil.

Drs. G. R. Brown and S. M. Darling were co-authors of the report, delivered to the American Chemical Society meeting.

## Control Taste of Milk

➤ THE TASTE of milk can be controlled and changed by chemical means, scientists were told at the American Chemical Society meeting.

The major loss in palatability of milk products is caused by odorous chemicals absorbed from the animals' feed, Dr. Vladimir N. Krukovsky, Cornell University, told a symposium on milk and its products. Rancid odor and bitter taste are caused by the breaking down of fats in raw milk. Chemical reactions also cause metallic or fishy, oily and, occasionally, cardboard-like flavors in milk and milk products.

Vitamin C and oxygen play an important part in these chemical reactions, Dr. Krukovsky said. Rapid chemical methods have been developed for lowering the total vitamin C content. Not only do these methods postpone the harmful effects, but they also remove feedy flavors, he added.

Dr. R. D. McCarthy, Pennsylvania State University, reported on the microorganisms within the cow that affect the production of milk. Feed is degraded and altered by bacteria and other organisms in the first stomach of the cow, he said. These microorganisms chemically change substances in the cow's food. The changes are an essential part of the digestion process.

By selecting certain microorganisms or by stimulating them to change their chemical composition, the digestive products can be altered. In some cases, Dr. McCarthy concluded, this can have an important effect on the metabolism of the cow and the composition of milk.

## Amino Sugars Clue to Life

➤ THE SYNTHESIS of amino sugars may lead to the understanding of important life processes, scientists were told at the American Chemical Society meeting.

Amino sugars are found in every part of the organic world, Dr. Roger Jeanloz, Massachusetts General Hospital, Boston, told Science Service. They have been detected in many living organisms, from the simplest plants, such as mushrooms and microorganisms, through the whole animal kingdom, up to man.

The function of amino sugars in living processes is barely known yet, Dr. Jeanloz said. However, he reported, many of the substances containing them, such as enzymes, hormones, anticoagulants and antibiotics, have important biological activities.

When an organism is under stress or is diseases, the amount of amino sugar increases. This may lead to the use of these substances in the detection of cancer, Dr. Jeanloz said, but this application has not been thoroughly studied.

Glucose, or simple blood sugar, is an abundant chemical in the body, Dr. Jeanloz noted, but it has not been found as a part of more complex building blocks. Amino glucose, a nitrogen-containing sugar, is a part of such complex molecules as proteins and fats.

It is known that an amino sugar is responsible for the growth promoting activity of human milk. This substance is not found in cow's milk, and some milk producers have added it to cow's milk in an attempt to reproduce "mother's milk," Dr. Jeanloz told Science Service.

By applying the most recent synthetic methods, Dr. Jeanloz concluded, scientists will have sufficient quantities of amino sugars to study their important role in life.

## Sex Hormones Analyzed

➤ A SEPARATION technique has been developed to analyze sex hormones in minute amounts, the American Chemical Society was told.

The sex hormones that control our mental and physical health occur in extremely tiny quantities in the body, Dr. Edward C. Jennings Jr., Wilkens Instrument and Research, Walnut Creek, Calif., said. In order to study the physiological function of the hormones, they must be isolated from biological sources, made extremely pure and then used on test animals. Gas chromatography has been used to obtain greater purity, Dr. Jennings said.

A gas chromatograph is an instrument that separates one compound from the other and records the relative amounts of each species. A special chromatograph, aerograph Hi-Fi, has been especially designed to detect and analyze samples as small as ten micrograms, or one-third of a millionth of an ounce.

The hormones being separated are

so sensitive that even a slight change in temperature might cause them to rearrange or change in composition. However, no chemical changes take place within the instrument, Dr. Jennings said.

"Female sex hormones, or estrogens, are especially hard to detect," Dr. Jennings told Science Service, "since they are highly reactive compounds. The male hormones, androgens, are much easier to work with.

The chromatographic detection of hormones is also a quick, efficient method used by hospitals for analyzing blood samples after an operation.

## New Anti-Cancer Chemical

➤ ONE TYPE of tumor in mice has been inhibited by 90% to 100%, using a new organic compound containing nitrogen. It has not yet been tried on human beings.

Dr. John A. Carbon, Sandra M. Brehm and James D. Ratajczyk of the Abbott Laboratories, North Chicago, Ill., have found the piperazine derivative (A-20968) effective against carcinoma 755, a transplantable mouse tumor. It also shows activity against two common types of cancer, sarcoma 180 and leukemia 1210, he reported to the American Chemical Society meeting.

The new compound is modeled after a compound called A-8103, which is undergoing clinical tests at the present. Both of these compounds appear to be examples of the anti-tumor agents known as "alkylating agents," although they represent an entirely new type of chemical structure among the anti-cancer drugs.

The organic chemist will be able to synthesize many closely related compounds by varying the "acyl side-chain" in the structure. Further evaluation is planned.

## Paint for Nuclear Submarines

➤ WATER-THINNED latex paints will be used for the interior of nuclear submarines, the American Chemical Society meeting was told.

Conventional paints used on the interior of a submarine release poisonous substances long after application, Donald E. Field of the U. S. Naval Research Laboratory in Washington, D. C., said. Since nuclear submarines are underwater for prolonged periods, these contaminations are dangerous. An acrylic latex paint, developed at the Naval Research Laboratory, is free from air pollutants that would seriously cut down the time a submarine could spend underwater.

The new paint compares with an enamel in gloss, resistance to soil and ease of cleaning. It is superior in ease of application, Mr. Field said. Under

ordinary conditions the paint is dry to touch in 20 minutes, and may be scrubbed after 24 hours. This eliminates the delay of extended drying periods.

Mr. Field said that the use of paint in submarines is "essential in protecting the hull and machinery from corrosion."

An almost equally important use of paints, he reported, is to "increase the cleanliness and aesthetic appeal of the ship's interior, especially during long undersea voyages."

## New Method for Use of Algae

➤ A NEW method for using algae in space vehicles was reported at the American Chemical Society meeting.

Algae are green plants. They use light energy to convert carbon dioxide into oxygen and the protein needed for animal life in the chemical process called photosynthesis. Algae may therefore be used to support life in a space vehicle.

Dr. Arnold C. Frederickson of the University of Minnesota said the carbon dioxide demand of algae would be supplied by animal respiration, so that the space vehicle could be a self-supporting unit.

When the light energy is not used by a culture of algae, it rejects the energy as heat. The power supply of the system then has to be partly wasted in cooling, Dr. Frederickson said.

Since a space vehicle must carry either its own source of power or devices for collecting solar energy, low-energy utilization by an algae system increases the weight of the non-propulsive parts of the vehicle.

In most present algae culture systems the distribution of light does not allow the plant to make efficient use of the energy, Dr. Frederickson said. Near the surface, the light intensity is too high, and in the center the intensity is low.

Dr. Frederickson has developed a method to agitate the culture. This exposes all the cells of the culture to a more or less uniform intensity of illumination, he said.

Calculations show that it is possible to speed up the photosynthetic reactions by agitation, but that agitation will not increase the efficiency of energy utilization as much as desired.

"The predicted increase in efficiency is large enough, however, so that further research on the problem is indicated," Dr. Frederickson concluded.

## Glass Makes Plastics Lighter

➤ TINY, HOLLOW spheres of glass are making plastics lighter, more rigid and less flammable, scientists were told at the American Chemical Society meeting.

The colorless glass particles are about two one-thousandths of an inch in diameter and weight about one-third as much as water, H. E. Alford of the Standard Oil Company (Ohio),

said. They are made by a high-temperature fusion process, he told Science Service. They remain unchanged up to temperatures of about 1,200 degrees Fahrenheit in reinforced plastics, such as those used in boat hulls or auto bodies. The hollow spheres give 30% stronger moldings at weight saving of 20% to 50%

Articles with unique electrical properties can be produced when these low density hollow spheres are combined with a wide variety of plastics. These are finding considerable use in aircraft electronic parts, such as radomes and high frequency radio transmission, he said.

The glass microballoon particles, as they are called, also have fairly good thermal insulating properties and may have some application in acoustical installations.

"Much less dense articles are possible with this product than with any other type of filler material available today," Mr. Alford said. However, he noted, they do not solve all the problems for plastic fillers, since they will not work in applications where high pressures are involved.

## New Fungicide Promising

➤ An experimental seed and soil fungicide that shows promise on cotton, field corn, peanuts and vegetable seed was described at the American Chemical Society meeting.

The fungicide can control an unusually broad spectrum of soil-borne diseases in addition to a wide selection of viruses causing seed decay, Dr. William Diveley, Hercules Powder Company, Wilmington, Del., said. It also appears to have a low order of toxicity to mammals.

In a cotton seed experiment the newly developed fungicide was somewhat more effective than standard fungicides for control of a disease called pre-emergence damping off. The fungicide is a chemical based on cumene, which is in plentiful supply, Dr. Diveley said.

## New Drugs Relax Muscles

➤ Two new compounds that are not only good for relaxing muscles but act as sedatives and induce sleep were reported to the American Chemical Society.

Drs. Donald E. Heitmeier, A. P. Gray and Ernest E. Spinner of Irwin, Neisler and Co., Decatur, Ill., said these compounds, derived from the chemical pyrimidine, are five times as potent as mephenesin, a well-known relaxant. They have not been clinically tested yet.

These compounds have the jaw-breaking names of 2-(beta-hydroxy-phenethylamino)-pyrimidine, and 2-(beta - hydroxy - beta - diphenylethyl-amino)-pyrimidine.

## "Supermarkets" for Literature

➤ "SUPERMARKETS" of scientific literature are needed to keep pace with the facts and ideas overwhelming the science market, chemists were told at the American Chemical Society meeting.

"We must devise schemes of supplying information in units of manageable size and of reasonable price," Dr. Louis P. Hammett of Columbia University said. Dr. Hammett received the 1961 ACS Priestly Medal award for chemistry.

A scientist's work often cuts across traditional borderlines and subdivisions. It then becomes increasingly difficult for him to track down information he needs because it is often hidden away in a journal or meeting in another field, Dr. Hammett said.

Scientific information is subdivided and separated in the way it has been done historically, Dr. Hammett reported. It should be streamlined into a "supermarket," he urged. The burden of selection should be clerical and even mechanical.

## Chemicals Change Growth Processes

➤ CHEMICALS that hold, move or remove metals in the body are now being used in medicine, scientists were told at the American Chemical Society meeting.

Some metals are essential for the normal functioning of animal and plant tissues, Dr. Harold Hardman, Marquette University School of Medicine, Milwaukee, said.

Chemicals called chelating agents can combine with these metals. This ability can be used to benefit mankind, Dr. Hardman told a symposium on chelating agents in medicine.

Drugs that function as chelating agents can modify the activity of living cells when they combine with metals normally present in living organisms, Dr. Hardman said. One possibility is the removal of essential metals with a resulting change in growth and metabolism. This type of action may account for the anti-bacterial action of certain antibiotics.

Metals such as mercury and lead are not essential and may be harmful to animal tissues. They also can be combined and removed from the body by chelating agents, Dr. Hardman reported.

High concentrations of a metal in a particular organ or tissue can be removed by chelating agents, Dr. Hardman said. Wilson's disease is characterized by unusually high concentrations of copper in liver and brain. The disease can be considerably modified by chelating agents that remove copper from the involved organs.

Chelating agents may also be used to transfer heavy metals to an organism, for such ailments as iron deficiencies in plants or animals. Dr. Hardman said. The biological effect of a

metal can be intensified when taken by the organism in the form of a chelate.

This appears to be a promising area for further research in the treatment of metal deficiencies in agriculture and medicine, Dr. Hardman concluded.

Chelating agents can also modify the effects of radiation, Dr. Jack Schubert of the Argonne National Laboratory, Lemont, Ill., reported.

## Blood Enzyme Fingerprints

➤ DISEASES of the heart, liver and other body organs may be detected by a study of the enzyme "fingerprints" of the blood.

One of the enzymes found in the blood, lactic dehydrogenase (LDH), regulates several important chemical processes in the body, Dr. Kenneth F. Gregory of Ontario Agricultural College reported to the American Chemical Society meeting.

Dr. Gregory worked with D. Felix Wroblewski of the Sloan-Kettering Institute for Cancer Research, New York.

Whenever a body organ is damaged by disease, its enzymes are released into the blood stream. Each body organ has its distinctive mixture of the five forms (isoenzymes) of LDH. The LDH isoenzyme in the blood serves to identify the damaged organ in much the same way fingerprints identify persons.

Since the isoenzymes of LDH differ markedly in their resistance to heat; the amount of enzyme destroyed by heating at different temperatures is used to identify the mixture. A large amount of LDH destroyed by heating the blood serum at a relatively low temperature indicates liver disease. If a large amount of the LDH is not destroyed by heating at a relatively high temperature, heart damage is indicated.

The multiple nature of LDH is expected to be of value in the study of evolution and genetic relationships. Only one of the isoenzymes of LDH is reported to be present in birds; two in fish, amphibia, and reptiles; and up to five in mammals.

## Fresh Water From Sea

➤ ISRAEL is speeding up attempts to make fresh water from salt water, it was announced at the American Chemical Society meeting.

All recoverable fresh water sources in Israel will be used up in few years, Dr. Kurt Spiegler, Israel Institute of Technology, told Science Service. The only present sources are a few rivers, and underground pumping. Too much pumping in one spot, however, eventually yields salt water. The only real

solution to the problem is salt water conversion, he said.

Development has centered on two methods, electrical methods and freezing evaporation. The electrical method is especially suited to Israel's problems since the cost depends entirely on the amount of salt in the water.

Since the most abundant source of salt water is from 10 to 100 feet under the ground and contains less salt than ordinary sea water, the cost would be less. The electrical process can also be carried out on a small scale. In fact, household units will be for sale soon, Dr. Spiegler predicted.

Cost is still the primary factor in saline water conversion, Dr. Spiegler continued. It varies from one to two dollars per thousand gallons of water depending on economic factors. There have been lower estimates, and an effort is being made now to bring the price down to 50 cents or lower.

Cost is high because much energy is wasted in the process. The energy used is from 10 to 100 times more than the theoretical minimum needed, Dr. Spiegler said.

The use of atomic energy as the source of heat for saline water conversion is especially suited to Israel, where fuel supplies are low, Dr. Spiegler concluded. Further research, using low temperature reactors is required, he added.

## "Brown" In Baked Foods

➤ TECHNIQUES for isolating the "brown" in baked foods were reported at the American Chemical Society meeting.

The color-taste ingredient that makes baked beans, gravy, maple syrup or potatoes brown is formed from proteins and carbohydrates, Dr. W. W. Binkley, New York Sugar Trade Laboratory, said. Exactly what these compounds are and how they are put together are still mysteries today, Dr. Binkley reported, but modern chemical techniques have provided some valuable clues.

It has been found that one unit of protein and one of a simple carbohydrate combine in the first step of "browning." Also, a chemical has been found that removes the "browning" compounds from syrups and molasses.

The "browning" compounds change at temperatures above that of boiling water, and a technique of isolating them is to de-water solutions of these compounds without changing them, Dr. Binkley said.

# *Proudly Presented*

**Announcing new developments in the chemical industry and newly available chemical literature.**

## High Purity Tellurium In Commercial Production

➤ Penn Rare Metals Inc. of Revere, Pa. announced it is now producing high purity tellurium metal in commercial quantities and four new germanium salts in semi-commercial quantities. With the addition of the new salts, the firm has doubled its production capacity for germanium metals to 800 kilos per month, according to Manfred DeRewal, president.

The company's tellurium is 99.9999 per cent pure and is used in the preparation of thermoelectric materials and certain semiconductor compounds, Mr. DeRewal said. It has a carrier concentration of $10^{14}$ cc and a very low oxygen content.

The four new germanium salts are: Germanium tetrachloride, germanium tetrabromide, germanium tetraiodide, and germanium tetrahydride. They are used in epitaxial growth. In addition, the company is making available several organo germanium compounds.

Penn Rare Metals also manufactures germanium, cesium and rubidium metals and salts and other high purity inter-metallic compounds such as cadmium, selenide, bismuth telluride, lead selenide, lead telluride, high purity arsenic, indium, and gallium.

All the firm's products are sold through the Kawecki Chemical Company which owns 50 per cent of Penn Rare Metals' common stock and acts as its exclusive sales agent. Kawecki Chemical, Boyertown, Pa., manufactures rare metals and their compounds such as tantalum, columbium, selenium, titanium, boron, zirconium, and master base alloys.

## Properties of Polyethylene Described In New Booklet

➤ A new, 12-page brochure, describing the properties and characteristics of Ameripol Polyethylene — a new ethylene plastic polymer that combines durability with processability — has been published by Goodrich-Gulf Chemicals, Inc., Cleveland, Ohio.

The brochure describes this new high-density polyethylene manufactured in a plant built by Goodrich-Gulf specially for its production. The plant is designed around Goodrich-Gulf's development of a Ziegler activated-catalyst system.

Listed in the fully illustrated booklet are physical, chemical and electrical property charts as well as graphs comparing environmental stress cracking and environment resistance of Ameripol to other high density materials.

Also tabulated are figures to show thermal embrittlement resistance and resistance to heat of the new ethylene plastic polymer, graphic illustrations of processability and a description of testing procedures.

The insulation resistance of Ameripol and other materials is compared in chart form in a section dealing with application in wire and cable insulation. There is an illustrated sec-

tion on the use of Ameripol in pipe applications and several other recommended uses.

Copies of the brochure, entitled Technical Bulletin No. 1, can be obtained from Goodrich-Gulf Chemicals, Inc., 1717 East Ninth Street, Cleveland 14, Ohio.

## Systemic Herbicide Controls Quackgrass

➤ A NEW liquid herbicide that promises superior control of quackgrass, the weed that infests thousands of acres of cornland across the Northern United States, is being manufactured by American Cyanamid Company. According to Agricultural Division marketing director, E. H. Smythe, the new weed killer will be marketed under the tradename of Cytrol and has been tested extensively in the Northeast and Midwest.

With its primary killing power based on the well-known amitrol, Cytrol has not only demonstrated superior kill of quackgrass, but of other hard-to-kill perennials such as cattails, milkweed, and Canada thistle. Systemic in action, the chemical is absorbed into the plant and moves to all above and below ground portions killing roots as well as tops.

Available in one and five gallon polyethylene containers, Cytrol is completely soluble in water and permits easy cleaning of spray equipment. Cleared for use on cropland before planting corn, it does not leave persistent soil residues to damage either the corn or whatever crop is planted the succeeding year.

## New Silicone Solution Weatherproofs Paper

➤ A NEW air-drying solvent solution that substantially increases the resistance of paper and paperboard products to water and weathering has been developed by the Paper Chemicals Department of Warwick Chemical Division of Sun Chemical Corporation, Wood River Junction, Rhode Island.

Designated Impregnole 367, the new material is a mixture of General Electric silicone polymers and other film-forming ingredients. It has already been used with great success by automobile assembly plants in treating boxes for outdoor storage of spare parts. In this instance, Impregnole 367 was applied to finish boxes. The material can also be applied to sheet stock with equal success.

Impregnole 367 is designed to be used diluted in solvent to approximately 5 to 10% solids and may be applied by spraying or swabbing, followed by air drying. Its properties include: Flash point of more than 80° F; 50% solids; and it is non-corrosive.

## Filter Flasks with Replaceable Tubulations

➤ A PYREX Brand filter flask with replaceable tubulation has been introduced by Corning Glass Works to help reduce laboratory equipment costs.

The product was developed after in-use surveys showed that, in most cases of flask damage, breakage involved the tubulation.

With the new glass connector, accidental damage does not require replacement of the entire flask.

The tooled glass tubulation has a Neoprene rubber grommet at the base. The connector is inserted into a hole in the neck of the flask.

The manufacturer reported that these tubulations have been successfully tested under vacuum. Flasks with the replaceable tubulations are available with capacities of 250, 500 and 1000 ml.

## New Inhibitor Prevents Pitting

➤ A NEW acid inhibitor for sulfuric, sulfamic, phosphoric or citric acids in metal cleaning and pickling has been introduced by Armour Industrial Chemical Company.

A new liquid inhibitor, tradenamed Armohib 31, is an aliphatic nitrogen compound which is readily soluble in acid at use concentration and will not precipitate or cloud on use or standing.

Armohib 31 is a 100 per cent active compound. It may be added to acid baths or it may be added to concentrated liquid acids which can be diluted to the desired strength at the point of use.

The inhibitor is non-staining and free from objectionable odors. During use, it provides a thin foam blanket to prevent acid fuming and spattering.

Armohib 28 is another in the line of acid inhibitors produced by Armour. It has been re-formulated to give good solubility in hydrochloric acid solutions. It will not stain metals nor leave a deposit of film. This chemical is effective over a wide temperature range, and inhibits pitting action of hydrochloric acid.

For additional information, contact, Armour Industrial Chemical Company, 110 N. Wacker Drive.

## New Chemical Product Fights Fire Hazards

➤ A NEW chemical product designed to eliminate fire and slip hazards from oil and gasoline spills has been developed and is being marketed by The Penetone Company, Tenafly, N. J.

According to Penetone, the product, called Slix, is completely non-flammable, non-toxic, and odorless and is especially useful in breaking up oil slicks and removing flammable solvents from almost any surface.

Slix shatters oil film into microscopic particles, chemically coats each droplet and surrounds it with water. When the oil is dispersed, it may be flushed into drains without endangering the walls of the sewer system.

Spills of gasoline, naphtha or turpentine will remain dispersed up to 24 hours when treated with Slix. Oil spills, however, will remain fully controlled for approximately three hours depending on the size of the spill and the amount of Slix applied. If the oil returns to the water surface again, it can be redispersed with a high pressure spray or other type of agitation.

Also, Slix is most effective when used in diluted solution. When removing oil or fuel spills from roads, runways, docks, decks, or solid surfaces, an equal solution of Slix and water should be applied. If the actual quantity of the spill is known, one gallon of Slix solution should be used for each 20 gallons of spill.

Slix can be applied to almost any surface without harmful effects. It will not injure asphalt runways or stain concrete walks. When properly diluted, it can even be used to clean fire hoses and other fire fighting equipment.

Tests by Penetone show that Slix can be used successfully wherever petroleum oils, kerosene, fuel oils, gasoline, naphtha vegetable oils or similar materials have accumulated on waterways, roads, docks, decks, floors or driveways.

Slix has been successfully tested by fire departments, airports, plant engineering and maintenance presonnel and by other industries where spills constitute hazards.

For further information, write to Dept. P.R. 41, Allied Chemical's National Aniline Division, 40 Rector Street, New York 6, N. Y.

## New Metal Powders Announced

➤ COMMERCIALLY pure ingot iron and zirconium with 2% tin are now available in the form of spherical powders, 20 to 150 microns in size.

The solid, polished-surface microspheres are being produced by Linde Company, Division of Union Carbide Corporation, with their recently-developed spherodizing process. The new products are in addition to the currently in-stock line of aluminum alloys, nickel, nichrome V, #316 stainless steel, copper, and tungsten microspheres.

Although not in stock, some platinum and 99.999% pure aluminum microspheres have also been processed.

In the microsphere process, $\frac{1}{16}$ in. diameter wire is used as the starting material. It is processed in an inert atmosphere so that the starting alloy composition can be maintained in the final spheres of reactive metals. These spheres, which are less sensitive to handling, can be made in selected particle size ranges by screening or elutriation in experimental quantities and by shifting the process in volume production.

Microspheres are already being used in many applications requiring controlled porosity such as impregnated cathodes in high power tubes, sintered nuclear fuel elements, fuel cell electrodes and filters. They have also been employed as catalysts in solid fuel propellants, as gas chromatography absorption base materials, and in metal dispersion strengthening studies.

Current applications in evaluation include the addition of 10 to 20 percent microspheres for flowability in powdered metallurgical compacts as well as their addition for homogenous alloying of silver-aluminum semiconductor lead wire and ribbon.

Application inquiries and further information and technical data may be referred directly to the Crystal Products Department. Linde Company, 4120 Kennedy Avenue, East Chicago, Indiana.

# New Chemical Patents

**To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupon (but not stamps) for each patent ordered.**

## Separation of Hafnium From Zirconium

➤ THE HAFNIUM content of zirconium ores varies from about 1 percent to about 54 percent by weight with an average of about 3 percent. Zirconium and hafnium have very similar chemical properties, and for this reason it has been found extremely difficult to effect their separation.

Commercially available zirconium metal and zirconium compounds usually contain from about 1 percent to about 2 percent hafnium by weight. For most industrial applications, this material may be utilized with satisfactory results. However, it is necessary in some instances to employ an extremely pure grade of zirconium that is substantially hafnium-free. The unusually high neutron absorption cross-section of hafnium makes its presence undesirable in zirconium used as an internal structural material in neutronic reactors.

The hafnium content of commercial quantities of zirconium may be readily reduced to as low as 100 parts per million with about 96 percent overall yield of zirconium by a new process. U. S. Patent No. 2,938,769 has been issued for this process to Lyle G. Overholser, Charles J. Barton, Sr., and John W. Ramsey of Oak Ridge, Tennessee. They have assigned the patent to The United States Atomic Energy Commission for the United States of America.

In their process an acidic aqueous solution, containing the dissolved mixture of zirconium and hafnium with chloride ions, is extracted with a water immiscible ketone solvent containing thiocyanic acid. The ketone layer extracts hafnium selectively leaving zirconium in the aqueous layer. Methyl isobutyl ketone is one of the water immiscible ketones used in this process.

## Electrical Method For Sawing Diamonds

➤ THE WELL-KNOWN method for sawing a diamond is by means of a thin Phosphor bronze disc mounted on a rotatable spindle at the end of an arm. The periphery of the disc is coated with a suspension of diamond dust or powder in oil. The diamond to be sawn is lowered by supporting means on to the disc while the latter is rotating at a suitable speed. Periodically the coating of diamond powder has to be renewed. The sawing process takes a considerable period of time, extending to a day or more in a great number of cases.

Sawing of diamonds by this process can usually be achieved only if certain directions which are parallel to either a cube or dodecahedron face. The sawing direction cannot be varied by the operator at will.

An electrical method for sawing diamonds has been developed by Matthys Heerschap and Charlie M. Levitt of Crown Mines, Johannesburg, Union of South Africa. They have been given U. S. Patent No. 2,939,941 for their invention.

According to their process, the surface of the diamond is converted to graphite. The graphitized zone is contacted by two spaced electrodes which are caused to spark by impressing a voltage between them. The voltage varies between 1,000 and 15,000 volts. A force is exerted by the spark in a direction to effect the desired erosion of the diamond.

## Clay and Lime Remove Tars from Cigarettes

➤ FOR MANY reasons, clinical and esthetic, reduction in the tar yielded during the smoking of tobacco is highly desirable. These tars are considered to be potentially carcinogenic when deposited on human tissue. They are thought to be responsible for the sharp irritating taste imparted to smoke from a cigarette. Furthermore, tars produce disfiguring coloration of the teeth of many smokers. Filter-tip cigarettes were developed to remove tars from the tobacco smoke.

The use of an acid-activated clay and hydrated lime as an additive to cigarette tobacco is described in a patent issued to Charles A. Specht of Englewood, N. J. by the United States Patent Office. The patent No. 2,938,818 was assigned to Minerals and Chemicals Corporation of America of Menlo Park, N. J.

The preferred ratio of the additives is from 2 to 10 percent. The optimum ratio should be determined for each specific tobacco composition. The quantity of tars generated during smoking varies considerably with tobacco specie and the presence of tobacco treating agents such as humectants, invert sugar, cocoa, essential oils, chocolate and licorice. Suitable ratios of clay to lime lie within the range of 1/5 and 5/1.

## Preparation and Storage Of Para Liquid Hydrogen

➤ HYDROGEN exists in two forms, one form being ortho hydrogen and the other para hydrogen. Ortho hydrogen is known as an unstable, high energy type, while the para hydrogen may be designated as a stable, lower energy type. The two forms of hydrogen possess slightly different physical properties, such as specific heat and vapor pressure.

In the equilibrium state hydrogen consists of a mixture of the ortho and the para forms of hydrogen. The ratio of each form present is dependent upon the temperature. At 20 degrees Centigrade the ratio is 75 percent ortho and 25 percent para hydrogen. As the temperature is lowered the ratio changes so as to give a higher percentage of para hydrogen. The conversion of ortho hydrogen to para hydrogen liberates heat. This has caused the storage of liquid hydrogen to require heavy, cumbersome, refrigerating equipment.

U. S. Patent No. 2,937,076 has been issued to Charles R. Class and Glen E. McIntosh of Boulder and to Raymond P. Spero of Arvada, Colorado for inventing a process that produces stable liquid para hydrogen. They have assigned to patent to Beech Aircraft Corporation of Wichita, Kansas.

In this process gaseous hydrogen is precooled and then passed into a heat exchange zone containing a para magnetic oxide catalyst that converts the ortho hydrogen to para hydrogen. Other steps in this process include an expansion zone to accomplish partial liquefaction.

Refrigerating equipment is not needed for the storage of para liquid hydrogen since it is a stable liquid not giving off heat. With a mixture of ortho and para liquid hydrogen, the constant conversion of ortho to para at the low temperature produces heat which causes the liquid to boil. In the case of ordinary liquid hydrogen approximately 75 percent of the hydrogen is boiled off and lost by this process.

## Struvite Crystals Prevented In Canned Sea Food

➤ It is well-known that canned cooked fish develop transparent crystals known as struvite upon standing. While not harmful, either chemically or physically, struvite crystals resemble glass fragments and when present, render the fish or shell fish unfit to eat in the opinion of uninformed consumers.

Struvite chemically is hydrated magnesium ammonium phosphate and it slowly forms in the canned fish and shell fish upon standing, usually on the inside surface of the can, and on the surface of the meat. The amount of magnesium ions, ammonium ions and phosphate ions in the flesh of the fish and shell fish, and in the surrounding fluid or juice, varies considerably with the type of product and the method of canning it, but is generally sufficient to form the objectional struvite crystals.

Ernest Geiger of Los Angeles and Sprague H. Watkins of Long Beach, California have developed a process to prevent the formation of struvite crystals in canned seafood. They have been given U. S. Patent No. 2,937,096 for their invention.

The process involves the addition of phytic acid to the seafood prior to sealing the cans. Phytic acid is the phosphate ester of hexahydroxycyclohexane. Either phytic acid or its sodium salt or a mixture of the two may be used in concentration varying from 0.25 per cent to 1.5 per cent.

This patent was assigned by the inventors to Van Camp Sea Food Company, Inc. of California.

## Molecular Weight Reduced by Irradiation

➤ The production of plastics with specified molecular weight ranges is important since the success of molding and extrusion is determined by the molecular weight of the material used. One of the methods used today to control the molecular weight of these materials is degradation.

Molecular degradation processes are both mechanical and chemical. Mr. John Rehner, Jr. of Westfield and Mr. William John Gilbert McCullough of Plainfield, N. J. have been awarded U. S. Patent No. 2,936,271 for a process involving gamma radiation.

In their process high molecular weight polyethylene or polypropylene is exposed to gamma radiation in the range of 0.1 to 50 megaroentgens in an oxygen containing atmosphere. This result is entirely unexpected since gamma radiation usually causes cross-linking in plastic materials.

This process was developed to accompany a new process for polymerizing ethylene and propylene. This process used aluminum alkyls and titanium halides as catalysts. This is a process yielding high molecular weight products.

By irradiation the molecular weight of one sample was reduced from about 325,000 to about 30,000. The temperature in this process may be varied from 0 degrees Fahrenheit to 250 degrees Fahrenheit.

This patent has been assigned to Esso Research and Engineering Company of Delaware.

## Flouridated Water Safe

➤ Opposition to artificially fluoridated water is not justified. Water fluoridation is both safe and beneficial, Dr. W. D. Armstrong, head of the department of physiological chemistry of the University of Minnesota Medical School, told a Congressional committee.

The safety and benefits of fluoridated water have been established by the use of radiofluoride in the human and in experimental animals, he said. Dr. Armstrong blamed public apprehension to fluoridation on poor public relations by the scientific community.

"We have not been vocal enough," he declared.

Studies have shown that neither nutritional nor metabolic alterations are able to increase or decrease calcium or phosphate content of mature teeth.

"Only in the case of fluoride do we have confirmed evidence for the enrichment of a tooth constituent after tooth formation."

Dr. Armstrong's defense of fluoride was a part of his report to the Joint Congressional Committee on Atomic Energy on applications of radioisotopes and radiation in the life sciences.

Radiofluoride studies in man and experimental animals have shown that a safety valve protecting against excessive fluoridation is provided by rapid renal excretion of the chemical.

Radioisotopes have made it easy to compare the effectiveness of various kinds of dental restorations (fillings or crowns). Studies show that all of the fillings now in use leak. It is hoped, Dr. Armstrong said, that further use of radioisotopes will lead to the development of leakproof materials for dental repairs.

The commonly used silver nitrate, phenol and alcohol for cavity sterilization actually appear to increase the permeability of the tooth. The radioactive elements used in research have shown that zinc phosphate and mixtures containing calcium hydroxides, which are less caustic, provide better sealing protection for the cavity.

# New Anesthetics Theory

➤ A NEW THEORY of how anesthetics bring about unconsciousness was proposed by Dr. Linus Pauling, Nobel laureate professor of chemistry at the California Institute of Technology.

Dr. Pauling's concept is that the anesthetic action is upon the fluid part of brain tissue, which makes up about 80% of the brain. This is contrary to earlier theories based on the idea that anesthetic agents act by dissolving fatty substances in the brain, thus changing their properties in some unspecified way.

Unconsciousness is caused, according to Dr. Pauling's theory, by the action of anesthetics in causing the formation of submicroscopic crystals that interfere with the electrical activities of the brain.

When the brain fluid is cooled to 81 degrees Fahrenheit microhydrate crystals are formed from its normal constituents. This causes complete anesthesia in the absence of any anesthetic.

Unconsciousness is brought about at body temperature (98.6 degrees Fahrenheit) by the use of an anesthetic. This is due to the fact that molecules of the anesthetic enter the hydrate crystal structure causing them to form at the higher temperature.

Dr. Pauling estimated that only one-tenth of one percent of the aqueous or fluid material of the brain need be converted into tiny crystals to bring about unconsciousness and insensitivity to pain.

As evidence to support his theory, the scientist pointed out that mixing chloroform or another anesthetic with water causes the formation of minute crystals and that there is a "striking parallelism between the concentration of the anesthetic gas required to form the hydrate crystals in the laboratory, in the absence of brain tissue, and the concentration of the gas required to produce anesthesia."

The new theory is the first detailed one based on molecular properties of anesthetic agents. Dr. Pauling said that the effectiveness of anesthetic agents is proportional to the calculated energy of attraction of their molecules for water molecules, as is required by his theory. This explains why divers become unconscious from nitrogen while breathing air under high pressure, he reported. When the divers are at considerable depth and the concentration of nitrogen is sufficient in the brain tissue, molecules of this element stabilize hydrate microcrystals.

This effect is prevented by replacing the nitrogen by helium, because helium atoms have a very small attraction for other molecules and do not stabilize the formation of hydrate microcrystals, he said.

Dr. Pauling presented his concept before the Hawaiian Section of the American Chemical Society and the physics society, Sigma Pi Sigma, at the University of Hawaii.

The molecular theory of anesthesia was developed by Dr. Pauling in the course of a program of investigation of the chemical basis of mental disease.

For the Home Lab

# Chemistry and Perfume

*by* Burton L. Hawk

➤ Well, the first signs of Spring have arrived. After an unusually severe winter, spring will be doubly welcome. While we are in the romantic mood which usually accompanies the first signs of spring, this will be an ideal time to prepare phenethyl alcohol and phenylacetaldehyde. For both of these substances have a fragrant odor of roses particularly apropos to the season.

Needless to say, phenethyl alcohol is used extensively in the compounding of perfumes. It is found in nature in essential oils of rose, carnation, hyacinth, orange blossom, etc. It is prepared by the reduction of ethyl phenylacetate with alcohol and sodium. Thus, our first step is to prepare the ethyl phenylacetate.

## Ethyl Phenylacetate

While the ester of phenylacetic acid can be made from the acid in the usual manner, it can also be prepared directly from the nitrile. The latter, we believe, is more readily obtainable, so we will use it as our starting material. The compound is known by two names: *phenylacetonitrile* or *benzyl cyanide*. You should be able to purchase it, under one name or the other, from a chemical supply house such as Fisher Scientic Company.

Although this experiment is not hazardous if proper care is exercised, nevertheless we do not recommend it for the completely inexperienced. Please follow instructions carefully and do *not use* larger quantities than those indicated. Work carefully and observe all the safety precautions.

Mix together in a 250 ml. Erlenmeyer flask 11 cc. of benzyl cyanide and 18 cc. of absolute ethyl alcohol. Carefully add 3½ cc. of concentrated sulfuric acid and mix the liquids by gently shaking the flask. If you have difficulty in securing absolute alcohol, a high quality denatured alcohol (such as Formula SDA-30) may be substituted.

Insert a 2-hole stopper in the flask. Through one hole carefully push a thermometer until it is immersed in the liquid in the flask. Through the other hole insert a long piece of straight glass tubing. It should extend about ½ inch below the stopper inside the flask and about 36 inches high on the outside from the top of the stopper. This tube serves as a reflux condenser and will permit us to boil the solution for a long period without excessive loss due to evaporation.

It is necessary to heat the mixture for about three hours. An oil bath is recommended to do the job most effectively. If you wish, you may use Crisco, Spry or similar type vegetable shortening for this purpose. Place the shortening in an old saucepan and carefully heat until it is completely melted. The pan should be about one-third to one-half full. Now carefully

lower the flask and immerse it partially in the liquid fat and secure it to the ringstand. Arrange your source of heat so that the temperature of the liquid will remain between 100 and 130 deg. C. during the 3-hour period.

After the time of heating is completed, remove the flask from the oil bath and carefully remove the stopper. Slowly pour in 75 cc. of hot water and shake the flask for a few minutes. Transfer the contents to a wide-mouth beaker and allow to stand. The ethyl phenylacetate will separate as an oil.

## Phenethyl Alcohol

Phenethyl alcohol (phenylethyl alcohol), is obtained from the reduction of ethyl phenylacetate using sodium and absolute alcohol. Using a medicine dropper, carefully draw off 5 cc. of the ethyl phenylacetate prepared above and transfer to another beaker. Be most careful that you transfer only the oil and *NOT* any water with it! Add to the oily liquid, 15 cc. of absolute ethyl alcohol and stir until the liquid is clear. Now metallic sodium is added and this portion of the experiment must be performed with utmost caution. Remember that sodium reacts violently with water and must be kept dry. Never touch it with your bare hands . . . always use pliers or tweezers. For this reaction, you will need a piece slightly larger than an ordinary marble. Remove the sodium from the protecting oil, cut off this sized piece and dry between blotting paper or with a cloth. The metal can be cut easily with a sharp knife. Cut off a *very small* sliver and drop it immediately into the liquid in the beaker. Keep you face away! The reaction will be moderately vigorous, however, if there is any water in the mixture the reaction will be quite violent. Continue to add the sodium *in small pieces* until all has been added and dissolved. Heat the beaker now and allow the liquid to boil gently for about five minutes. Pour about 1 cc. of this mixture into 10 cc. of water in another container. Shake vigorously and then smell cautiously. You should be able to detect the floral odor characteristic of the rose.

## Phenylacetaldehyde

The aldehyde of phenethyl alcohol smells more rosy than the alcohol itself. It is formed by the conventional oxidation, with chromic acid as the preferred oxidizing agent. Prepare 10 cc. of a concentrated solution of potassium dichromate. Heat, if necessary, to dissolve the crystals, then cool by holding the container in cold water for a short while. Add 3 cc. of concentrated sulfuric acid to the cooled solution and stir. Now add about 5 drops of the phenethyl alcohol prepared above and shake the tube gently. The liquid turns black. Smell cautiously at the mouth of the tube. At first there is a possibility of the formation of acetaldehyde from the excess ethyl alcohol that may be present in your phenethyl alcohol. If so, it will vaporize quickly. After the tube stands for about 30 seconds, smell at the mouth again. By now you should be able to detect the odor of phenylacetaldehyde . . . reminiscent of roses in the moonlight! Ah, yes.

## √ *Chemistry Quiz* √

*Directions:* Mark the answer you think *most nearly correct.*
Answers are on page 45.

A. When dilute hydrochloric acid reacts with marble a gas is produced. Which of the following statements is not correct?
   1. Water is also produced in this reaction.
   2. The gas produced is lighter than air.
   3. Heat is produced by the reaction.
   4. The gas produced has a reddish color.

B. What volume of oxygen under standard conditions would react with 16 grams of sulfur?
   1. 22.4 liters.
   2. 16 liters.
   3. 32 liters.
   4. 11.2 liters.

C. The effect of the rays from radioactive materials on photographic plates was first noted by
   1. Pierre Curie
   2. Madame Curie
   3. Henri Becquerel
   4. Albert Einstein

D. Propane gas ($C_3H_8$) burns to produce carbon dioxide and water. When one cubic foot of propane burns, how much air is required?
   1. 9 cubic feet.
   2. 4 cubic feet.
   3. 25 cubic feet
   4. 22.4 liters.

E. Neon has an atomic weight of 20. How does its density compare with that of oxygen?
   1. It is less.
   2. It is the same.
   3. It is more.
   4. It depends upon the volume.

## *On the Back Cover*

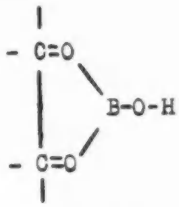
➤ THE BACK COVER *shows the new high-vacuum molecular distillation equipment making its debut at Battelle Memorial Institute under the watchful eye of Glenn W. Kinzer. Known as the microfractor, this new research "tool" invented by Dr. K. C. D. Hickman can be used to resolve mixtures of materials with molecular weights in the* 250-1000 *range that are otherwise difficult or impossible to separate. Components of a mixture, separated on the basis of differences in volatility, are deposited in strips on the moving metallic bands within the vacuum chamber. The microfractor — the only one in existence — is being used initially at the Columbus, Ohio, research center in a pharmaceutical study. Kinzer and his associate, Frederick Benington, anticipate use of the microfractor in research involving the separation of dyes, alkaloids, steroids, and chemical compounds in their natural state.*

# Sugar-Boron Complexes

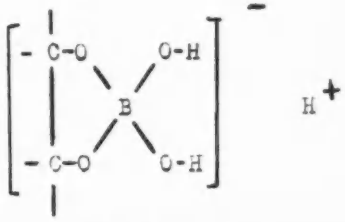
*by* Margaret Kottke
*Bladensburg Senior High School, Bladensburg, Maryland*

**Margaret Kottke, 17, was a winner in the 20th Science Talent Search. She hopes to major in botany at college with a view to becoming a college teacher.**

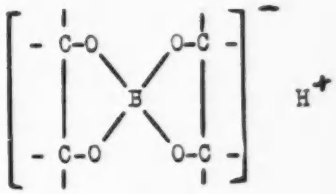
➤ Boric acid and borates form complexes with polyhydroxy substances which have adjacent (cis) hydroxyl groups on the same side of the carbon chain. The hydrolyzed borate ion forms covalent bonds with the cis pair, losing two water molecules. Three possible types have been suggested by Boeseken:



*Complex A*



*Complex BD*



*Complex $BD_2$*

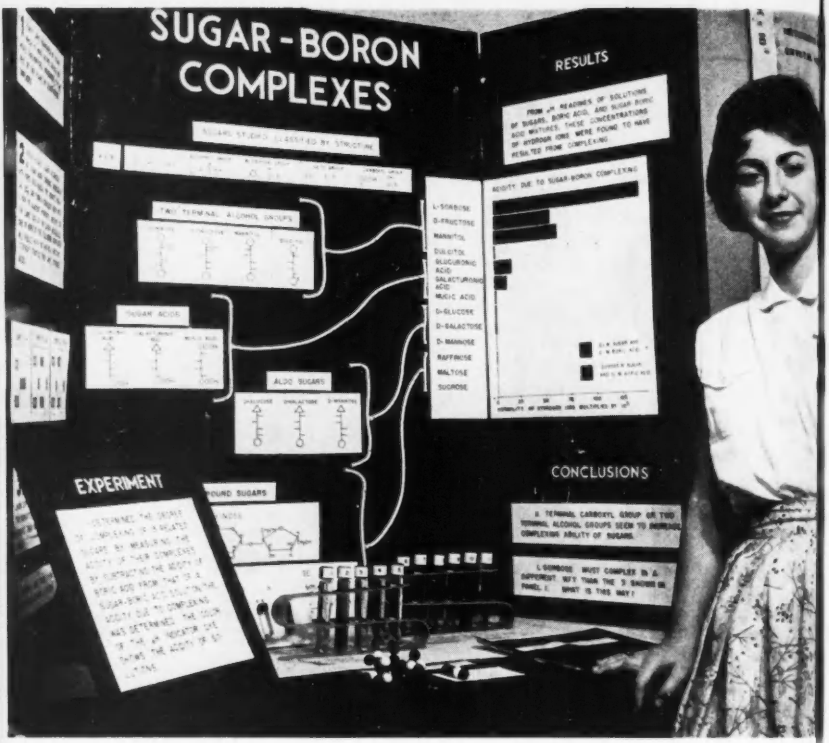
In high relative concentrations of boric acid, types A and BD are favored. When the ratio of boric acid to sugar is low, type $BD_2$ predominates.

In my preliminary experiments I found that several sugars, each of which had a single pair of cis hydroxyl groups, complexed with boric acid in very different degrees. Therefore, I decided to study sugars[1] with single-step differences in structure in order to find characteristics which might be present in compounds which complex well, but missing in related compounds which do not.

## Materials and Methods

Boric acid was the source of the borate ion.

[1] Throughout this paper the word *sugars* will refer to sugars, sugar alcohols, and sugar acids.




➤ Margaret Kottke, *with her science display which she exhibited in Washington as a feature of the twentieth annual Science Talent Institute. Margaret was one of the 40 Science Talent Search winners who were chosen from over 25,000 high school seniors throughout the country.*

Knowing that D-fructose and mannitol complex strongly, and that D-mannose, D-galactose, and D-glucose complex weakly, I chose for my experiments these compounds and the ones listed below, with structural similarities to them.

| | |
|---|---|
| L-sorbose | mucic acid |
| dulcitol | sucrose |
| glucuronic acid | maltose |
| galacturonic acid | raffinose |

Paper chromatograms were made of samples from all available bottles of the sugars I planned to study to

determine whether they were contaminated with other sugars. The solutions were spotted two inches from the edge of the paper, which was folded and dipped into a solvent of 40 parts butanol, 10 parts acetic acid, 22 parts water. When the solvent front reached the bottom of the paper, it was dried, then "run" again. A chromatogram of all samples was sprayed with the sugar-revealing reagent, aniline phthalate. A separate chromatogram of mannitol and dulcitol was sprayed with a 5% solution of silver nitrate in an excess of ammonia to reveal any sugar alcohol contaminants. They were baked and examined under ultraviolet light. All sugars sampled were found pure except D-galactose, D-mannose, and maltose. I wrote to Dr. Horace Isbell of the National Bureau of Standards. He sent me samples of each of these, which I tested and found chromatographically pure.

The stock solutions of boric acid and sugars were made to twice the desired molarity. Solutions of sugar or acid alone were then diluted with water. Equal volumes of sugar and boric acid diluted each other. As mucic acid is almost insoluble in water, it, D-galactose, and galacturanic acid were tested at 0.00025 M. The complexes formed instantly.

Complex A ionizes only slightly, but BD and $BD_2$, the predominant complexes, ionize strongly, forming

## RESULTS

Normality of Hydrogen Ions Due to Complexing of Sugars With 0.1 Molar Boric Acid

| | Sugar | | Normality[1] |
|---|---|---|---|
| Two Terminal Alcohol Groups | 0.1 M | L-Sorbose | 144. |
| | 0.1 M | D-Fructose | 58.0 |
| | 0.1 M | Mannitol | 63.8 |
| | 0.1 M | Dulcitol | 1.01 |
| Sugar Acids | 0.1 M | Glucuronic Acid | 15.5 |
| | 0.1 M | Galacturonic Acid | 12.8 |
| | 0.001 M | Galacturonic Acid | 2.67 |
| | 0.00025 M | Galacturonic Acid | 0.27 |
| | 0.00025 M | Mucic Acid | 1.57 |
| Aldoses | 0.1 M | D-Glucose | 1.71 |
| | 0.1 M | D-Mannose | 0.21 |
| | 0.1 M | D-Galactose | 1.40 |
| | 0.00025 M | D-Galactose | 0.07 |
| Compound Sugars | 0.1 M | Raffinose | 0.65 |
| | 0.1 M | Maltose | 0.71 |
| | 0.1 M | Sucrose | 0.35 |

[1] All normality values have been multiplied by $10^5$. Each value is shown to its last significant figure.

more acidic solutions than the original boric acid. I found pH values of the solutions with a Beckman battery-operated pH meter to determine the acidity which arose from complexing.

pH values were converted to normality of hydrogen ions. The value for water was subtracted from that of each solution. The values for boric acid and each sugar were added to find the concentration of hydrogen ions which would be expected from blending of the two solutions if no complexing occurred. This value was subtracted from that observed to find the normality of hydrogen ions which arose from complexing.

## Discussion

The three sugars which complexed most strongly were L-sorbose, D-fructose, and mannitol. All three have two terminal alcohol groups and L-sorbose and D-fructose are keto sugars. Dulcitol, the other sugar with two terminal alcohol groups, did not show strong complexing.

The sugar acids, galacturonic acid and glucuronic acid, which have single terminal carboxyl groups, formed complexes ionizing considerably more than related D-galactose and D-glucose. Mucic acid, which has two terminal carboxyl groups, indicated even more complexing than galacturonic acid and glucuronic acid.

The aldoses, D-glucose, D-galactose, and D-mannose, all of which have cis pairs of hydroxyl groups, complexed very little. Perhaps their small complexing ability is due in part to the fact that the aldehydes easily form ring structure. The double-bond oxygen of carbon one joins with the hydroxyl group of carbon five, eliminating one of D-mannose's cis pairs and D-glucose's only pair. This does not explain very well, however, the small complexing of D-galactose, whose cis pair are the hydroxyls of carbons three and four.

The compound sugars, raffinose, maltose and sucrose, have no cis pairs of hydroxyl groups, but showed slight complexing.

An unexplainable result was the *very* strong complexing of L-sorbose with boric acid — stronger than that of mannitol, which is the compound in general use for practical purposes. L-sorbose has no cis pair of hydroxyl groups and theoretically should not complex!

## Conclusions

Since several sugars, each with single pairs of cis hydroxyl groups, show very different degrees of complexing, there must be factors other than number of cis hydroxyl pairs which influence their ability to complex. My results indicate that a terminal carboxyl group or two terminal alcohol groups may greatly increase complexing of a sugar.

Some sugars which have no cis pairs of hydroxyl groups and thus cannot complex in the known way, do complex. L-sorbose complexed very strongly, causing twice the acidity of any other sugar tested. Three compound sugars which have no cis pairs also complexed slightly. There must be a way of complexing which does not require a cis pair of hydroxyl groups, and the behavior of L-sorbose shows that it must be very important.

# Pfizer

**This is the eighth of a series of eight articles to be presented in CHEMISTRY this year. Many of the students now preparing for a career in chemistry will eventually join one or other of the large corporations and this series, featuring eight of the major companies employing chemists in the United States, is intended as a preview into the type work that they will be doing.**

➤ When Chas. Pfizer & Co., Inc. was established in Brooklyn in 1849, the enterprise consisted of two men and one product. The two young men, soon to become brothers-in-law, were Charles Pfizer, a chemist, and Charles Erhart, a confectioner, both newly arrived from the Kingdom of Wurttemberg. They acquired a small building in Brooklyn, N. Y., and started to manufacture the medicinal santonin.

The partners soon began the manufacture of other fine chemicals and before the end of the century the company had become an important supplier for the pharmaceutical and food industries.

From the modest plant at the corner of Brooklyn's Harrison Avenue and Bartlett Street, still in use by the company today, Chas. Pfizer & Co., Inc., has emerged in 112 years as one of the nation's foremost chemical and drug manufacturing concerns and, more recently, as one of the world's largest producers of antibiotics. Today the company operates four domestic manufacturing plants, maintains extensive laboratory facilities, employs more than 18,000 persons and does business in the four corners of the globe. Six separate divisions are engaged in the marketing of an ever-widening list of products, from antibiotics to anti-nausea drugs, from blueprint chemicals to beverage ingredients, from plasticizers to poultry remedies.

The company at first served the infant pharmaceutical industry. During the Civil War it branched out to the production of ingredients for food processors and in 1862 Pfizer became the first domestic producer of tartaric acid and cream of tartar. Eighteen years later, the company began producing citric acid from imported crude citrate of lime which was made from the culls of citrus fruit. The demand for citric acid by the food and pharmaceutical industries grew rapidly and Pfizer soon became one of the leading producers.

It was the company's interest in the fermentation of citric acid that set in motion a chain of events which made possible the tremendous growth in the past decade and a half.

## Early Research

In 1914, long before industrial research became the prevalent pursuit it is today, Pfizer started its first major research project. The goal was to

➤ AERIAL VIEW *of the new Medical Research Laboratories of Chas. Pfizer & Co., Inc., in Groton, Conn., adjoining the company's modern production plant. The three-story steel and concrete research building contains 177,000 square feet and houses macrobiological, chemical and biochemical research departments. To the south of the building is a residential area.*

find a new method of making citric acid from more readily available raw materials, materials which were less subject to restricted supply and price fluctuations.

Experiments were begun on the production of citric acid by fermentation, using sugar as a raw material. In 1923, after almost a decade of research, Pfizer was operating the first fermentation plant to produce citric acid in commercial quantities. Later, the controlled fermentation process was successfully applied to the production of other organic chemicals, among them oxalic acid, gluconic acid, itaconic acid, riboflavin and vitamin C.

It was this background in fermentation techniques which enabled Pfizer to take the leadership in the production of penicillin during World War II and later to become one of the early producers of streptomycin.

Post-war research led a team of Pfizer scientists to the discovery in 1949 of the broad-spectrum antibiotic, Terramycin, which is effective against more than 100 disease organisms. Continuing expansion of research led

▸ MICROORGANISMS *isolated from soil samples collected around the world are processed, identified and stored in Maywood's culture "library." Shown are plate cultures, test-tube agar slants and flasks containing molds grown in liquid nutrient.*

the company into many fields which now range from vaccines to cancer, from animal health to metabolic diseases.

## Medical Research

The new Medical Research Laboratories in Groton, Conn., give impressive testimony of Pfizer's recognition that research is "the life-blood of the industry." Staffed with 400 scientists, technicians and supporting personnel, equipped with the finest research equipment available, these laboratories completed the first full year of operations in 1960. Virtually all the scientific disciplines are represented at Groton with the heaviest concentration being among chemists, biochemists and pharmacologists.

The broad research program under way at the new Groton laboratories covers many fields of scientific study, including the investigation of mental

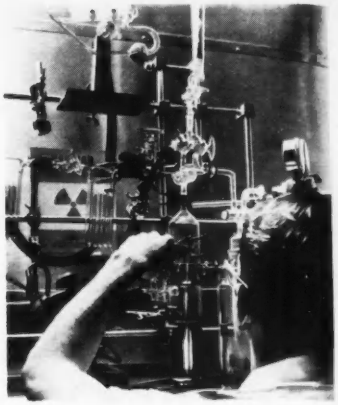
illness and the so-called degenerative disorders accompanying the aging process. Emphasis is being placed on studies of atherosclerosis, diabetes and cardiovascular diseases and several new drugs have already emerged from these new laboratories and are undergoing clinical evaluation.

A unique process developed by Pfizer scientists for producing the nucleus of the penicillin molecule has enabled the company's researchers to create over 2,000 different synthetic penicillins. The first of these to be marketed, Maxipen, was introduced last year. Another penicillin shows promise of effective action against resistant staphylococci and a broad range of other disease-producing organisms. Although some new synthetic penicillins have been found effective against microorganisms, they must be administered by injection. This new penicillin can be taken orally.

## Vaccines

At Pfizer's Biologics Research and Development Center at Terre Haute, Ind., scientists are working on the development of vaccines for immunization against the adenoviruses, which affect the upper respiratory system, and against measles and other communicable diseases. A large-scale field trial of a new measles vaccine, a fruit of this research, was begun recently March 20, 1961 in Buffalo, N. Y., by the Erie County Health Department and the University of Buffalo Medical School. The Buffalo test was prompted by "encouraging results" obtained in smaller clinical trials conducted in several cities last fall with the Pfizer vaccine.

Active in biological research and development for the past five years, Pfizer already markets a polyvalent influenza vaccine and a Salk-type polio vaccine produced in Terre Haute.



➤ RADIOACTIVE CARBON *is being used in this drug metabolism study at the Radiochemistry Laboratory, Pfizer Medical Research Laboratories, Groton, Conn. Drugs labeled with radioactive materials unlock information about concentration of compounds in tissue, metabolic breakdown routes, molecular structures, rate of assimilation and also provide clues to biosynthesis and interactions of normal body chemicals excreted.*

Along with the laboratories at Groton and Terre Haute, Pfizer also carries on research in Maywood, N. J., and in England, India, France, Chile, and other parts of the world. Added to this program enabling physicians to conduct studies with Pfizer drugs in hospitals, universities and medical institutions throughout the world.

At Pfizer's plant in Sandwich, England, pilot production of the Sabin-

type oral polio vaccine was started early in 1960. Sample production lots have been submitted to the British and Japanese governments in preparation for the sale of vaccines in these countries when approved. Here at home, Pfizer is in the course of applying to the U. S. Public Health Service for a license to market its oral polio vaccine in the United States. Meanwhile, an extensive laboratory and animal testing program for this vaccine is going forward at Sandwich, England.

## Cancer Drugs

For several years, Pfizer scientists at the John L. Smith Memorial for Cancer Research in Maywood have devoted themselves to a quest for effective anti-cancer drugs. Working under grants from the National Institutes of Health, researchers last year screened some 8,000 substances, including agents developed at Pfizer's Groton Laboratories, and other compounds extracted from soils and botanicals gathered from all parts of the world. Although a number of agents have reached the clinical testing stage, so little is known about the causes of cancer that progress in this field is necessarily slow.

## Plastics

At Pfizer's plant in Greensboro, N. C., the main area of concentration is in the manufacture of plasticizers and other products for the plastics industry. Among the chemicals produced there are dimethyl itaconate, a building block in the manufacture of plastic products, and acetyl-tributylcitrate marketed as Citroflex A-4.

The company which was formed by the two young men from Wurttemberg had about 2,700 employees in 1949. Today there are some 18,000 Pfizer employees in the U. S. and abroad. A dozen years ago, there was not a single Pfizer employee, not a single Pfizer product being produced, packaged or even labeled outside the United States. Today Pfizer products are manufactured in 21 countries, Pfizer has its own sales organizations in 47 countries, and Pfizer products are available in more than 100 countries around the globe.

√ Answers to CHEMISTRY QUIZ on Page 36. √
A - 2; B - 4; C - 3; D - 3; E - 1.

# Next Element will be Different

➤ THE NEXT new chemical element to be made by man, No. 104, will have properties entirely unlike the other synthetic elements, Nos. 93 through 103. The finding of element No. 103 closes the books on the actinide series since it is the last one of this group of the building blocks of the universe.

Element No. 104 should resemble hafnium and zirconium in its physical and chemical properties since it falls directly under them in the periodic table.

The various compounds of the next new element should be relatively easy to separate from the compounds of the actinides by solvent extraction, since there are marked differences in solubility.

The series of elements to be opened up by the discovery of element No. 104 are the fourth of the so-called "transitional metal series." These will include elements No. 104 through 112, if and when they are produced. The elements No. 112 through 118 will complete the seventh row in the periodic table, and also will have different properties.

The larger the atomic number, the shorter the life of the element. The half-life of element No. 103 is found to be about eight seconds. The chance of the production and identification of elements beyond No. 103 grows progressively dim. Element No. 110 has a predicted half-life of one-hundredth of a second, which may be the limit of discovery.

Element No. 103 was produced by bombarding three-millionths of a gram of californium with boron-10 or boron-11 nuclei having energies of about 70,000,000 electron volts. This was accomplished using the heavy ion linear accelerator (HILAC) in the Lawrence Radiation Laboratory of the University of California in Berkeley.

Californium was bombarded with boron nuclei and then the californium atoms emitted neutrons, thus changing the californium into element 103. The very few atoms of 103 so formed were caught on a thin copper conveyor belt that carried them in front of a series of silicon crystal detectors. Here alpha particles with 8.6 million electron volts of energy were detected. Final proof of the existence of element 103 consisted in carrying out experiments to rule out the possibility of the alpha particles coming from atoms of nobelium or mendelevium.

The atomic weight of this new element is thought to be no more than 257 but further work is planned to determine this accurately.

Since 1940, University of California scientists have discovered or participated in the discovery of ten synthetic elements heavier than uranium — from neptunium, element No. 93, through element No. 102. Who gets the credit for the discovery of element No. 102 is still a matter of controversy. A research group in Stockholm, Sweden, reported its preparation in

1957 but their results were disputed by the California scientists.

A report on the research leading to the discovery of element No. 103 has been submitted to the Physical Review Letters by Drs. Albert Ghiorso, Torbjorn Sikkeland, Almon E. Larsh and Robert M. Latimer. Their work was supported by the U. S. Atomic Energy Commission.

The discoverers have suggested that the element be named lawrencium in honor of the late Dr. Ernest O. Lawrence, Nobel Prize winner, founder of the laboratory in which the discovery was made.

*"I still say they're pampering our engineers too much!"*

# Book Condensations

KINETICS AND MECHANISM: A Study of Homogeneous Chemical Reactions — Arthur A. Frost and Ralph G. Pearson — *Wiley,* 2nd ed., 405 p., $11. Contains new material on gas phase and solution kinetics, free radical and chain reactions.

LABORATORY STUDIES IN GENERAL CHEMISTRY — Frank Brescia and others — *Academic,* 210 p., illus, paper, $3.25. Basic techniques of laboratory operations and 54 experiments requiring measurement, observation, calculation and interpretation of result.

TEXTBOOK OF INORGANIC CHEMISTRY — S. Young Tyree, Jr. and Kerro Knox — *Macmillan,* 434 p., illus., $7. Treats the chemistry of all the elements at the same level, thus giving an over-all view of the variety of chemical behavior.

ALCHEMY TO ATOMS — Ellsworth Newcomb and Hugh Kenny — *Putnam,* 128 p., illus. by Eva Cellini, $2.95. The story of chemistry for young readers.

INDUSTRIAL ORGANIC NITROGEN COMPOUNDS — Melvin J. Astls — *Reinhold,* 392 p., $14. Summarizes the chemistry of most of the organic nitrogen compounds used in industry.

THERMODYNAMICS — Gilbert Newton Lewis and Merle Randall, rev. by Kenneth S. Pitzer and Leo Brewer — *McGraw,* 2nd ed., 723 p., $12.50. Updated textbook for advanced chemical courses.

ORGANIC CHEMISTRY — Keith M. Seymour — *Prentice-Hall,* 321 p., $9. Introduction to the basic principles of organic chemistry written for a one-semester course.

GAS CHROMATOGRAPHY — Henry J. Noebls, R. F. Wall and Nathaniel Brenner, Eds. — *Academic,* 463 p., illus., $16. Proceedings of the Second International Symposium held under the auspices of the Analysis Instrumentation Division of the Instrument Society of America, June, 1959.

THE BIOCHEMISTRY OF MUCOPOLYSACCHARIDES OF CONNECTIVE TISSUE — F. Clark and J. K. Grant, Eds. — *Cambridge Univ. Press,* 125 p., $4.75. Biochemical Society Symposium, held in London, February 1960.

THE STORY OF ALCHEMY AND EARLY CHEMISTRY — John Maxson Stillman — *Dover,* 566 p., paper, $2.45. Reprint of 1924 work entitled "The Story of Early Chemistry."

A MANUAL OF SEA WATER ANALYSIS — J. D. H. Strickland and T. R. Parsons — *Fisheries Res. Bd. of Canada (Queen's Printer),* 185 p., paper, $2. Basic working instructions for analysts undertaking oceanographic chemical analyses.

SOURCE BOOK OF THE NEW PLASTICS, Vol. 2 — Herbert R. Simonds, Ed. — *Reinhold,* 310 p., illus., $8.95. Covers new materials and processes in the plastics industry through most of 1960.

# Chemistry Comments

**Interesting facts in the chemical world.**

➤ A contract for a one-million-gallon-per-day plant to convert sea water to fresh water was awarded by the Department of Interior's Office of Saline Water.

➤ A new magnet wire with tough yet thin insulation has unusual abrasion resistance and operates continuously at temperatures of more than 260 degrees centigrade.

➤ Soviet oil exports are now running at a rate of close to 400,000 barrels a day, an increase of almost 100% in two years.

➤ In 1939 a net ton of tin plate contained 31 pounds of tin; today, with the use of steel, a net ton of tin plate has only 11.9 pounds of tin.

➤ Explosives are being used to form metals.

➤ Soviet oil today accounts for 80% of the total supply to Finland and 27% of Greece's total petroleum imports.

➤ Soviet oil exports currently comprise about five percent of the Free World demand outside the United States and Canada.

➤ In the first four months of 1960 the can industry bought 1,281,749 tons of steel as compared with 6,467 tons of aluminum, the next most popular packing metal.

➤ Israel is the third largest diamond center in the world and the largest producer of small stones from one-half to one-fiftieth of a carat.

➤ A wooden fence post lasts only a few years in the ground unless it is properly treated with wood preservatives.

➤ The composition of sugar, hydrogen, oxygen and carbon, is the same regardless of whether it is refined from sugar cane or sugar beets.

➤ Low-cost, all-solid-fuel U. S. rockets could put a man on the moon by 1967.

➤ Atomic radiation might soon be used for curing leather commercially.

➤ Polluted air poisons many plants in the United States, destroying the older leaves first and gradually killing the entire plant.

➤ At one time 15 grades of brown sugar, which is composed of small sugar crystals covered with a film of highly refined, dark-colored syrup, were produced, but now there are four grades, three of which are common household items.

➤ Sugar was the only commodity rationed during World War I.

➤ U. S. space and missile system research in 1962 will account for more than half the total military research and development budget.

➤ Engineers' salary level rose nearly five percent each year in the United States between 1958 and 1960; the overall median salary now stands at $9,600 per year.